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Toward Developing Adaptive Processes for Integrating Science and Stewardship in Natural Resource Management

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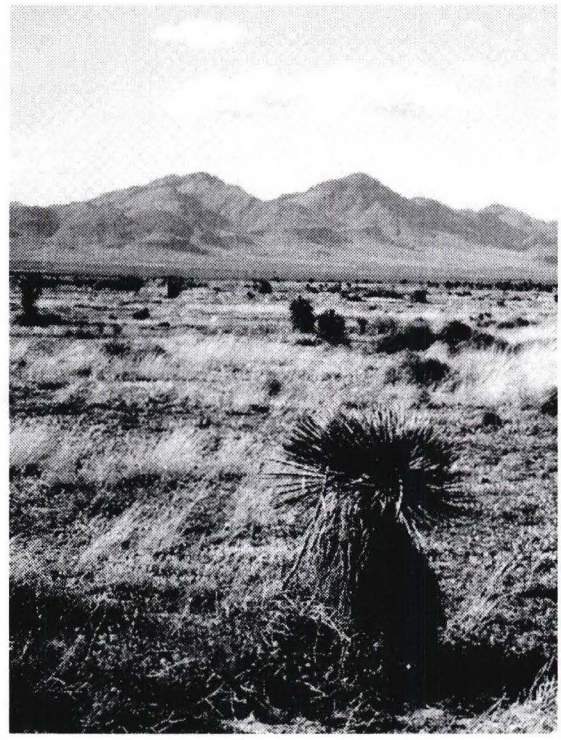

Final Report to the Rocky Mountain Research Station 2005

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Executive Summary:

This season combined ecological research with analysis of the social implications of science and stewardship. The McKinney Flats Project completed its eighth year and the second post-drought season with rainfall at or above the 10-year average. The student intern program completed its sixth season, with interns assisting with lizard, small mammal, and snake sampling. Vegetation sampling was completed in December. In addition to sampling our twenty study plots, we added four control plots adjoining the prairie dog towns to examine if the differences between prairie dog treatments and control plots are a reflection of the action of prairie dogs, or the background environment. Lizard numbers and diversity appear to be below recent levels, whereas small mammals exhibited considerable increases returning to pre-drought levels recorded in the late 1990s. In 2006, now that fuel and forage have returned to pre-drought levels high enough to support burning and grazing treatments, we will returning to the full sampling design the was initiated in the 1990s.

The social facets of the research included an analysis of a series of comparative studies. Contrasts between Maasai from East Africa and Malpai ranchers conducted in collaboration with David Western (African Conservation Centre) highlight the importance of sustaining rangeland form and function and how fragmentation of landscapes has community, ecological, economic impacts for rangeland cultures and the landscapes that sustain then. A cross-site analysis of three Southwestern United States. rangeland projects in collaboration with Maria E. Fernández-Giménez (Colorado State University), Bernardo Aguilar-González (Prescott College), and Tischa Muñoz-Erickson (Northern Arizona University) illustrates the importance of integrating biological and social analysis. Collaboratives place a high value on economic factors, but have had limited success in implementing these programs. Developing effective feedback loops between research and monitoring and adaptive management is a major challenge facing all three organizations. A final case study contrasts the Malpai Borderlands Group with the Downeast Initiative from Maine. The comparison of these organizations provides important insights into the role of scale, and effective governance institutions in attaining relevant resource management. Key to getting the scale right is developing feedbacks of knowledge. This is primarily attained through community-based science programs. In addition to contrasting fisheries and rangelands in this project the process of community-based science developed by the Malpai Borderlands Group was applied to the development of more resilient fisheries. The result of this comparison indicates that even in radically different systems, the approach taken by the Malpai Group is exportable and widely applicable. Key to the process is developing a systems view of the form and function of the ecosystem based on the integration of local/community and science-based knowledge. From the social science related programs undertaken this year two invited book chapters are in preparation in addition to the three papers contained here in the appendix. One is a chapter on the use of knowledge by collaboratives that will be contained in a book on community-based management edited by the University of Virginia's Community-based Collaboratives Research Consortium (the publisher is yet to be determined). A second is a chapter on community-based science is be included in a book on long-term approaches to science to be published by Columbia University Press.

Introduction:

The following is an end of the year report on science projects in the Malpai Borderlands and related programs. This year has been marked by a focus on not just the biological facets of resource management in the borderlands, but also detailed investigations of the socio-economic context within which science and resource management must operate. The reason for this focus on biological and social interactions is three fold:

First, with a decade of collaborative management and science in the borderlands behind us it is a good time to reflect on what has been accomplished. What has worked and what has not, and what are the broader lessons that can be applied to the borderlands and similar projects across the nation and globe.

Second, several years of drought and the associated management challenges has brought great opportunities to better understand the structure and function of the borderlands ecosystem. Yet they have also delayed implementation of a number of our experimental treatments. While we wait for the additional years of data and the completion of our initial round of experimental treatments it is a good time to reflect on the social implications before the next phase of the biological science program moves forward.

Third, the experimental work in the borderlands has demonstrated that alternative frameworks for science can be immensely powerful in not only making science more relevant to communities and resource management. But also in expanding the frontiers of basic science. Through non-traditional partnerships between ranchers and scientists the scale and scope of the science and monitoring programs have been expanded to make them much more relevant to understanding large-scale natural processes and in testing the underlying assumptions of management. There are few examples of successful integration of science and community-based conservation. Leading to the question if the lessons from the borderlands are exportable to other systems, or a special case? A series of projects contrasting the Malpai Borderlands program with others around the nation and globe examine the process undertaken in the borderlands and its broader implications for conservation and science in general. While also asking what lessons from other projects can be applied in the borderlands to improve the effectiveness of these rangeland conservation programs.

I. Field Studies on McKinney Flats:

The 2005 calendar year was the second with rainfall patterns typical of long-term averages prior to the drought. Because the final data are not yet in for 2005 final measurements do not exist. As of November 2005 the yearly totals for precipitation were ranging from 12 to 14 inches. This is well in excess of recent years, especially in the eastern parts of the study area that were ranging from 4 to 6 inches per year in 2001 through 2003. The existence of two years if pre-drought data, four years of drought data, followed by two of post drought data provide an important opportunity to examine the interaction of drought with grassland composition.

For the sixth season the summer field work was conducted in conjunction with the summer internship program. Six students from the Animas High School were engaged in the research, as well as several college students from around the country. This season the internship program was coordinated by University of Arizona graduate student Kevin Baker in conjunction his studies of the snake community.

For the sixth year field studies were completed on the lizard community across the twenty experimental plots (16 core treatment plots plus 4 prairie dog towns), The sampling was completed in early June, early July, and early August. The analysis of 2005 data is not complete. But early results indicate that the lizard numbers are considerably down from previous years. Ironically the lizard numbers peaked at the height of the drought indicating that these organisms do not respond to overall system productivity, This year, as in 2004, the pitfall trap data was augmented with the funnel trap data collected in the course of the snake studies. We also conducted local contrasts of lizard communities inside, and adjacent to the prairie dogs to determine if differences in lizard diversity between prairie dog and control plots are due to the prairie dogs, or underlying environmental factors. Soils on prairie dog town are consistently different from those found in other parts of the research area leading to the question is differences in biota on the prairie dog towns from control plots are the result of differences in soil, or the actions of prairie dogs.

This season for the eighth year mammal studies were conducted across the research plots. Sampling occurred in July, August, and September to attain pre and post monsoon measurements. In contrast to the lizards, mammal numbers were up dramatically from previous samples returning to, or exceeding, pre-drought and fire measures from 1998. Of particular interest was the number of woody habitat related species such as the wood rats that has been largely absent since the pasture burned in 1999. While grassland specialists such as cotton rats were returning to prairie habitats, Kangaroo rat numbers were considerably below previous years (especially early in the season). We hypothesize that the wet winter may have caused a loss of seed stores and a decline in Kangaroo abundance. Overall the diversity is also increasingly dramatically compared to previous seasons. As with the lizard studies the funnel traps associated with the snake studies augmented the mammal data capturing additional species rarely associated the Sherman traps (this data was not included in the overall species analysis). Preliminary results from contrasts between prairie dog plots and adjoining areas are mixed, but suggest that differences between prairie dog small mammal assemblages and adjoining areas are the result of prairie dogs and not soils.

The studies of snake community by Kevin Baker and associates from the University of Arizona continued for a second season with radio-tracking Prairie Rattlesnakes (*Crotalus viridis*)(n = 17). Tracking began in February of 2005 as January was too wet. Snakes were active in February and through the rest of the spring and summer. Tracking snakes continued daily through September 2005. In October 2005 snakes during the weekends. November 2005 through mid March 2006 snakes will be tracked two weekends per month. In mid to late March 2006 daily tracking snakes will recommence. We also continued trapping snakes in the four pastures on McKinney Flats in 2005. Traps were

opened in mid March and ran periodically (typically 10 days open and 4 days closed) until May 30, at which time the traps were sampled continuously. The traps were shut down for the season on 30 September and will re-open in mid March 2006. Using the present protocols, Kevin Baker and associates plan on continuing both trapping and telemetry aspects of this study in 2006. At present there is discussion of converting the species assemblage study into a doctoral project for Kevin. If this happens, University of Arizona scientists may need to test different variables in the system, take blood samples from snakes for genetic analysis, add or remove traps, and overall expand the resolution of the study..

In December 2005 the eighth vegetation Myles Traphagen and associates conducted sampling on McKinney Flats. Sampling was completed on all 20 sampling plots, as well as the four prairie dog control plots. Biomass sampling will be completed in January 2006. Though the results are just in and yet to be analyzed the preliminary results suggest that the vegetation response to the summer's rainfall is not as strong as suggested by the relatively high moisture levels.

For 2006 analysis of post-drought data will be a major emphasis of the program. In 2006 we plan to return to the original experimental design that we needed to abandon at the height of the drought due to a lack of fine fuels for fire and feed for cattle. We plan to burn the entire pasture in May 2006 and will begin reintroduction of cattle following the growing season is vegetation re-growth and recovery is adequate. A major challenge facing the project this coming season is how to sustain lizard sampling and find funds to support detailed analysis of the long-term data sets. Recent declines in funding level (over $40,000 in 2005) mean we will have to set priorities and many have to cut some programs to sustain the overall integrity of the project.

II. Comparative Studies of Social Frameworks for Science and Stewardship:

Over the last 18 months a primary focus of the research program has been on addressing the underlying processes by which science and stewardship are achieved. This program contains three facets including: 1) Comparative analysis of rangeland conservation in East Africa and Southwestern North America; 2) Comparative analysis of rangeland conservation in the southwestern US; and 3) Comparative analysis of the integration of science and community-based conservation contrasting the Malpai Borderlands Group with fisheries conservation in Eastern Maine.

Comparisons of the South Rift Valley and Malpai Borderlands:

Entitled informally the "Two Cowboys Project" this work begun in 1999 in collaboration with David Western of the African Conservation Centre. The goal of this project has been to contrast science and stewardship processes in East Africa and the borderlands. While these systems may seem very different, the climates of the two regions are very similar. Both have bi-modal rainfall patterns and contain grassland and savanna biomes. The East African rangelands still contain their great herds of mega fauna, whereas those in North America have been lost. The primary utility of the process is that whereas the Maasai of

East Africa are being pushed to sub-divide their land and develop European-style range management practices. Whereas borderlands ranchers are working to build more collaborative land management practices that mitigate current fragmentation and reduce the likelihood of future subdivision of the land (attaining open landscapes similar to what still exists in parts of East Africa). For these reasons these groups had much to teach each other. While the Malpai ranchers have embarked on an intensive science-based stewardship program. The Maasai have over thirty years experience with developing community-based collaboratives.

The initial visit by North Americans to East African occurred in the fall of 2002. While a return visit by Maasai occurred in the spring of 2004. An additional visit to East African by borderlands ranchers occurred in 2005. For this year much of our efforts have focused on writing up the results of the meetings into a paper for the journal Conservation Biology. The preliminary draft (see appendix one) is now being edited by David Western. The results of the analysis highlight the importance of developing global learning networks that provide different individuals, organizations, and cultures insights into the problems faced by similar peoples, and a new understanding into how to better carry-out their own initiatives. Specifically, the role of sustaining large, resilient ecosystems was key in both cultures. This preservation was often conducted through integration local and science based knowledge.

Comparison of Western Rangeland Community-based Collaboratives:

This project was developed in collaboration with Maria E. Fernández-Giménez of Colorado State University, Bernardo Aguilar-González of Prescott College, and Tischa Muñoz-Erickson form the Northern Arizona University. This work was primarily funded by a grant from the Hewlett Foundation through the Community-based Research Consortium at the University of Virginia. The aim of this project was to develop a conceptual framework and analysis tools to assess the adaptive capacity of community-based collaborative groups (CBCs), to test these tools by applying them to three rangeland collaboratives, and to identify factors that contribute to the adaptive capacity of CBCs. We developed a conceptual framework for assessing the adaptive capacity of CBCs and used this framework to guide development and implementation of a quantitative survey to assess the adaptive capacity of three rangeland CBCs, the Malpai Borderlands Group, the Diablo Trust, and the Northwest Colorado Stewardship. We also constructed in-depth qualitative case studies of each group's adaptive learning process following our framework. Eight factors that affect adaptive capacity were identified: a holistic approach that embraces complexity, commitment to learning and monitoring, vertical vs. horizontal decision-making structures, financial and other resources, trust, bureaucracy, linkages with and awareness of the broader social-ecological context of the CBC, and finding the appropriate social and ecological scale (See appendix two).

This paper is currently in the process of being re-written for publication. These initial results highlight the importance of developing effective institutional structure to sustain collaborative projects, but the analysis highlight that while all organizations emphasize the importance of socio-economic processes. Few directly address these factors. The

biological sciences are much more widely applied, but are probably of less direct relevance to the future of many CBCs. All three groups, and every other group encountered face fundamental governance issues to assure their sustainability and the long-term relevance of their programs.

Processes Governing Integration of Science and Community-based Collaboration: Comparison of Rangelands and Fisheries.

This project contrasts the efforts of the rancher-led Malpai Borderlands Group from the rangelands of southeastern Arizona and southwestern New Mexico with the fledgling Downeast Initiative whose efforts are to restore a diversified fishery to Eastern Maine. It may appear the most radical differences are that one system is wet, while another is dry. In many ways even more striking is that the fishery contains a common pool resource with open access, while ranchers have a well-defined system of property rights. While the fishermen face many of the same open-access related issues that faced ranchers in the days of the open range a century ago, ranchers have found the system of property rights and access to federal lands increasingly constraining such that many ranches are no longer ecologically or economically viable. Thus fisheries are managed at scales that are too large, while ranches are managed at scales that are too small. The contrast of these systems provides important insights into the role of scale, and effective governance institutions in attaining relevant resource management. Yet key to getting the scale right is developing feedbacks of knowledge. This is primarily attained through community-based science programs. In addition to contrasting fisheries and rangelands in this project we apply the process of community-based science developed in conjunction with the Malpai Borderlands Group to the development of more resilient fisheries in Maine (See appendix three).

The results of this comparison indicate that even in radically different systems, the approach taken by the Malpai Group is exportable and widely applicable. Key to the process is developing a systems view of the form and function of the ecosystem based on the integration of local/community and science-based knowledge. The process of developing research programs does more then just develop the feedback loops necessary to adaptively manage. It also develops common ground, shared understanding, and trust between individuals and organizations that frequently had very different perspectives. This developed of an adaptive process based on communication and learning is essential to developing resilient, sustainable, natural resource management systems.

Summary:

In both the biological and social facets of the research program effective, sustainable conservation lies with getting the scale right. This scale is not just spatial and temporal, but also institutional. The preliminary results from McKinney Flats emphasis the importance of working across scales and of looking at the dynamics of multiple interacting variables. These secondary, or indirect efforts are frequently of more relevance to management then the original, primary interaction. Likewise, developing relevant, large-scale science rests with getting the social context right. The Malpai

example illustrates the power of alterative social frameworks in getting more applicable science developed. Yet all organizations seem to fall short when it comes to developing effective feedback loops that integrate different kinds of existing science, and new knowledge as it is developed. A fundamental disconnect also still lies between linking biological, economic, and social systems. In particular the time scales of the conservation project being undertaken (in the case of the Malpai Borderlands decades to over a century) are considerably longer then the social institutions that typically operate on much shorter time horizons.

From the social science related programs undertaken this year two invited book chapters are in preparation in addition to the three papers contained in the appendix. One is a chapter on the used of knowledge by collaboratives that will be contained in a book about community based collaboration for environmental protection being edited by the University of Virginia's Community-based Collaboratives Research Consortium (the publisher is yet to be determined). A second is a chapter on community-based science is to be included in a book entitled "The Biology of Place" to be published by Columbia University Press.

Appendix I.

Draft in Preparation

Rangelands as a global conservation resource: Lessons from cross-cultural exchange between pastoral cultures in East Africa and North America.

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Maasai Dennis Sorbone: "*Many thousands of miles away from were I come from are people with similar issues and threats to their way of life.*"

Rancher Bill Miller: *"As a lifelong hunter is has been my dream to see the wildlife of East Africa. Yet now that I am here though I find the wildlife impressive, it is the Maasai people and their culture and way of life that moves me the most."*

Introduction:
Grasslands and savannas cover over 40% percent of the earth's land surface and are found in every terrestrial region of the world. It addition to their relative abundance, these areas are of considerable importance to human survival. Grasslands have been the seedbeds for the ancestors of virtually every major cereal crop including wheat, rice, rye, barley, sorghum, and millet. They continue to provide the genetic material necessary to breed cultivated varieties that are resistant to crop disease. Grasslands are also of crucial importance as a carbon sink. In contrast to forest ecosystems, grasslands store considerably more carbon in soils then in vegetation. Grasslands are estimated to store approximately 34% percent of the total terrestrial carbon, in contrast to 39% in Forest Ecosystems the majority of which is in boreal ecosystems (White et al. 2000). Grasslands are some of the last holdouts for the remnants of the Pleistocene megafauna that once dominated the earth's biota (Flannery 2001). As recently as the late 1800s most of the Earth's grasslands supported large migratory populations of hoofed herbivores. These species included Bison bison on the North American plains, saigia antelope (Saigia tatarica) on the Eurasian steppe, swildebeest (Connochaetes taurinus) and zebra (Equs burchelli) on the African savanna, and the ecological equivalent kangaroos (Macropodidae) in Australia (Frank et al. 1998).

Yet these arid and semi-arid ecosystems have been disproportionately disturbed and/or destroyed by human activities (Sears 1935; Curtis 1956; Reisner 1986, Manning 1997; Frank et al. 1998; White et al. 2000). Prairies are the most threatened ecological community in North America. The once vast tallgrass praires of the Eastern Plains of North America have declined 97% percent since 1830. These patterns are not isolated. The recent decline of grasslands in Sub-Saharan Africa is the largest (approximately 3.5 million km^2). South America and Asia also have been considerably altered with declines of 1.4 million km^2 (especially northeastern Brazil) and 1.2 km^2, respectively (White et al. 2000, Chuluun and Ojima 2002).

Despite these profound changes grasslands are underrepresented in global conservation strategies. Though covering over a third of the globe, protected grasslands represent only 3% of total land area in parks or conservation areas, or just 7.6% percent of grasslands. Temperate grasslands have been described as the least protected biome in the world with only 0.69% under formal protection (White et al. 2000). In the late 1800s the worlds first parks were established to protect remnant mammal populations in the American West and in East Africa. Yet since this initial period of park establishment other systems have come to capture conservationists attention as the drive to preserve biodiversity rightly supercedes a preoccupation with charismatic mega fauna.

The disparity in the establishment of protected areas is a direct result of the importance of grasslands for agriculture and other human activities. Globally more human population inhabits grasslands then any other biome (White et al. 2000). In the American West, as elsewhere, rich lands with high potential for successful agriculture were deeded to European settlers with conservation lands largely relegated to those sites with less agricultural potential. In North America these patterns of settlement have meant that most parks and conservation areas were established in areas typified by "rocks and ice". Pretty places, but with relatively shallow soils, short growing seasons, and relatively low biotic potential (_____). For example, the National Wildlife Refuge System, the largest conservation system in North America, is primarily relegated to those sites were agriculture was not possible, or where it was tried and failed (Curtin 1991), Plains animals, for example grizzle bear (U. a. horribilis), came to be associated with montane habitats, rather then the open spaces that were once their domain. In the tropics the opposite pattern of European settlement occurred, but for the same reason. The relatively cool and moist highlands were relegated to farming and European settlement, leaving the relatively arid lowlands to indigenous peoples and wildlife. This pattern is seen in East Africa where the highlands to this day are primarily farmed by peoples of European decent, while the parks and remnant tribal lands remain in the relatively arid lowlands.

The patterns of land conservation also result because grasslands are intrinsically hard to preserve though traditional land acquisition approaches. This is because large open spaces and the ability for mobility in both animals and human components are the essence of grassland ecosystems. Without enough space to move in response to processes such as fire, and climatic variability the many of the biotic components of grasslands cannot effectively function. The vast mammalian migrations that once typified the American West, and that still can be seen in East Africa and in the Arctic are examples of the processes that must be bounded within a preserve design to assure a viable system. These patterns of mobility and dynamics are more then just issues of scale, they are essential to the very function of the system. For example, on the plains of East Africa the ability to track the richest vegetation by following the greening-up front as rains move across the landscape is a core factor underlying the profound numbers of mammals supported by East African ecosystems (Western _____). Without this energetic bonus derived from mobility, the great herds of East Africa and their associated ecosystem cannot exist.

All of these factors mean that grasslands are poorly adapted to conventional conservation approaches that still largely focus on saving "the rarest of the rare and the best of the rest". Preserving viable grasslands rests with conserving the "semi-natural matrix" (e.g. Brown et al. 2003), within the context of existing human cultures and with the recognstion that ecological and cultural components are equally important to preserving ecosystem structure and function. In East Africa pastoral groups such as the Maasai and their cattle have become integrated into ecosystem. Abandoned boma sites represent biodiversity hotshots with the mosaic of different age settlements distributed across the landscapes representing a important facet of the overall function of the ecosystem (Western _____). In the American West waters provided for cattle by ranchers also can benefit wildlife populations ( ). Fire, only possible through the protection of

open-space, is largely affordable as a management action only through the collaborative efforts of ranchers and public agencies (Curtin 2002, 2003). Even cattle, thought widely considered a threat to biodiversity (e.g Wuerthner and Matteson 2002), can serve an important role in preserving open space. In southwestern New Mexico and southeastern Arizona, USA under climatic conditions of much of the last 30 years shrubs where promoted over grasses (Brown et al. 1997, Betancourt 1998). Analysis of areal images and contrast with plots data on the ground have illustrated that in the face of climatic drivers that cattle, like other guilds of foraging mammals, can serve a key role in mitigating climatically driven vegetation change (Curtin et al. 2000, Curtin and Brown 2001).

In summary, in grasslands perhaps more then most ecosystems eparation of culture, economy, and ecology of these systems is all but impossible because: (1) These systems are intrinsically too large and dynamic to be easily captured within the bounds of a park of protected area; (2) The agricultural and settlement of these lands puts conservation uses in direct competition with other humans values (especially in the third world); and (3) Humans have long been responsible for maintaining the integrity of these ecological systems through such practices as burning. Therefore the solutions to their survival rests with maintaining the communities and cultures long associated with these ecosystems. Over the last several years we have explored the interaction of culture and ecology through a series of workshops between Maasai pastoralists from East Africa and ranchers for the southwestern USA. The results of these workshops highlight the utility of these adaptive learning networks, and the value of bringing together communities, even half a world apart, to benefit from each others experiences.

The Two-Cowboys Project: Interactions Between Pastoralists from East Africa and North America.

Starting in 2001 we have developed a joint project comparing conservation and land management of East African and Southwestern North American grassland ecosystems. We have undertaken this work because pastoralists, ranchers, conservationists and scientists from both regions have much to gain by interacting. In East Africa the rangeland is still largely open commons used by pastoralists and wildife much as it has been for several millenia. Government and international aid efforts are, however, aimed at introducing western style commercial ranching involving land subdivion and sedentarization. There is extensive evidence that the maintenance of grassland diversity and productivity rests on the mobility of herding cultures, with sedentarization and land fragmentation leading to loss of diversity and productivity (Western 1997). In contrast, rangelands in North America have been degraded by a century or more of enclosed static ranching with the natural dynamical processes such as fire and large ungulate herbivory heavily regulated or curtailed. In recent years, in areas across the southwest, ranchers have begun to see the necessity of reincorporating processes such as fire and more dynamic grazing practices into their lands (Curtin et al. 2002). Thus, as East Africa moves toward repeating many of the mistakes made in North America, American ranchers and researchers are realizing that to preserve open landscapes they must move back toward a model more similar to that still in existence in Africa. At the same time,

due to increases in human populations and supplemental water systems on both continents, the potential to overgraze the landscape, or degrade it through human population pressures, is greater than ever.

A dialog and working relationship between these diverse cultures can be essential to preserving the diversity and productivity of African landscapes, and restoring and sustaining American rangelands. The African experience of 5,000 years of grazing arid grasslands, and the American experience of dealing with the constraints of producing commodities in a post-industrial economy, mean these diverse groups have much they can teach each other. Because African community-based conservation (CBC) efforts are far better developed than North American, this comparative approach will do more to increase the understanding of North American processes and systems than could be achieved by a domestic approach alone (Western et al. 1994; Lenon et al. 2003).

The immediate objective of the meeting of these diverse cultures has been to define the underlying ecological, economic, and social networks, institutions and processes necessary to preserve arid grasslands and their associated human cultures. For the North American participants this has include rescaling the concept of rangeland to include natural processes such as fire, drought, and herd mobility, but finding creative ways to do this within the constraints of current market forces. For the African participants, the exchange has helped them appreciate the advantages and shortcomings of commercial livestock economies, marketing, individual land ownership, landowner associations and the like, but also the strength of many of their own traditional husbandry practices in sustaining ecology and culture in arid lands. It should be stressed, however, that the exchange we are forging is not the conventional meeting or workshop, but instead an iterative process based on a model of community involvement initiated at the 1993 Airlie, Virginia meetings on community-based conservation. Here, a series of discussions and interactions among the participants prior to the core meetings leads to appreciation and new understanding, and to a consensus building process in which issues are defined and addressed by the participants, not through predetermined directives (Western et al. 1994).

Beginnings – Developing a Foundation for Collaboration:
In the early 1990s the Board of the Liz Claiborne/Art Ortenberg Foundation (LCAOF) recognized that community-based collaboratives (CBCs) were emerging as a key conservation strategy, particularly in the developing world. At the same time they were troubled that many projects failed to live up to their potential. After examining the interaction of many conservation organizations with CBCs, the Foundation determined that while many organizations pay "Lip-service" to interacting with communities, that in reality it was still "business as usual". What emerged from these preliminary discussions was a workshop conducted at Airlie, Virginia in October 1993. The participants from Africa, Asia, Europe, Latin America, North America, and Oceania included a a range of disciplines including anthropologists, conservationists, indigenous people, managers, and politicians. What made the Airlie House meetings a departure from previous approaches is that issues and strategies were developed from the ground up with the communities defining the questions and working toward the solutions. The community-based

approaches were then compared between regions allowing the communities to learn from each other.

At the same time the Airlie meetings were being planned and executed, a group of neighboring ranchers and a few trusted conservationists and researchers were begining to gather on the porch of the Malpai ranch in southeastern Arizona. These individuals realized that the status quo of conflict rather than collaboration between different groups concerned with preserving open space was sure to lead to the demise of ranching as a livelihood, and the loss of open, functioning landscapes. They gathered to discuss other outcomes and how new approaches might lead to preservation of their land and culture. These informal meetings lead to the formation of the Malpai Borderlands Group (MBG) as an incorporated non-profit organization in 1994. The MBG has gone on to become one of the premier community-based collaboratives in North America with over 1 million acres in Mexico and the United States included within their planning area (Curtin 2002, Curtin 2005).

In the early 1990s as the Liz Claiborne/Art Ortenberg Foundation board met to consider proposals they were struck by the remarkable similarity between two proposals: One from Il'Ngwesi Maasai from central Kenya, the other from the fledging Malpai Borderlands Group in the Mexico-US borderlands. Though these groups were half a world apart the remarkable similarities in the issues they faced demonstrated the universal natural of many of the issues facing ranchland communities and cultures. This recognision, and the successful funding of both proposals, began a dialog between these the LCAOF board and diverse cultures that has continued to the present.

"He Who Has Been Far, Sees Far"(Maasai proverb): The Maasai-Malpai worlshops.

A recognsion of similarities between ranchlands of East Africa and North America is not new. From Teddy Roosevelt and other hunters of the late 19th and early 20th centuries, through John Wayne movies of the 1960s and countless other books, articles, and documentaries the similarities between these landscapes and cultures has been recognized. Yet it was the experience of the community-based approach taken at the Airlie House meetings linked with thirty years of experience with community-based conservation in East Africa and a nearly a decade of experience in the borderlands and provided the context for a fundamentally different approach (MacDonald 1995, Western 1997, Western 2000, Curtin 2002, Curtin 2005, Western 2005). One that was based on developing census around the core issues based on community input and believes, and the best available science. An approach that focused on bringing together a diversity of individuals and organizations focused on the task of joint learning and problem solving.

The preliminary meetings in Kenya arose out of a series of workshops with ranchers and researchers in the southwestern US. coordinated by the Columbia University/UNESCO Joint Program on Biosphere and Society (CUBES) that culminated in a conference at Columbia University in the spring of 2002. As a result of presentations at this conference funding was secured from CUBES, and the Santa Fe based Thaw Charitable Trust, for a preliminary series of workshops in Kenya in the fall of 2002. Additional supporters

included the African Conservation Centre that works with large-scale conservation project in East Africa and the Arid Lands Project that conducts research projects in the borderlands. The emphasis of these initial meetings was to bring over not just ranchers, but also some of their collaborators to emphasize to the Kenyan participants the importance of diverse coalitions. MBG president Bill Miller and his wife Carrol represented the ranching community. Other participants included University of Colorado Environmental Policy professor Douglas Kenny, UNESCO resource economist and CUBES field director Ben Lane, community organizer and Sonoran Institute Southern Arizona field representative Roseann Hansen, and Malpai Borderlands Group science coordinator and meeting co-organizer Charles Curtin. From October 6th through 16th the group met with Maasai in Kenya in the vicinity of Amboseli National Park, in the southern rift valley at Shampole north of lake Natron, and in Liakipia in central Kenya. In the course of the visit the group met with Maasai in a number of workshop and viewed first hand both the subdivision pressures currently facing the Maasai, and the collaborative ventures developed to sustain functioning cultures and ecosystems.

In the spring of 2004 from April 22nd throught 28th six Maasai from Kenya and Tanzania visited the borderlands to view ranching communities, ecology, and culture (I need their names and affiliations – I cannot find a complete list in my files). In addition to the African Conservation Centre, the Arid Lands Project, and CUBES, support for these meetings also came from the Sand County Foundation who sponsored the Tanzanian participants. This second meeting, in addition to exchange between Kenya and the United States, also developed a trans-border comparison with discussions of transnational issues between Kenya and Tanzania, and Mexico and the United States with representative of all four countries present. In contrast to the Kenyan workshops, these meetings focused on the Malpai Borderlands with a series of intensive discussions with ranchers across the borderlands. The Maasai viewed the outcome of a century of land subdivsion and learned first hand from ranchers the problems and pitfalls of working in a market economy, but also the benefits of interacting with a diversity of collaborators.

June 2005 – Should we discuss? I do not know the details.

Our Past Is Your Future: Lessons from the Maasai-rancher interaction.
At the meetings in Kenya in 2002 Malpai Borderland President Bill Miller stated"We are here to share our past with your future". This single statement, perhaps better than any, summarized the potential and promise of the Maasai-rancher workshops. If a picture is worth a thousand words, then a visit with another people is worth volumes. This situation is all the more the case in the Maasai-ranchers exchanges were the current patterns of institutionalized land fragmentation and problems associated with it are one very real potential outcome of current land-tenure patterns in Maasai lands in East Africa. Five core areas of discussion were the implications of dynamics and scale in functioning rangelands, wildlife, ecotourism, livestock management, science, and conservation easements and related preservation tools.

Dynamics and Scale:
In North America patterns of crisis or evidence of land degradation have repeatedly been met with the same solution: institutionalized subdivision of working landscapes. Conservation has long been interpreted to mean tighter control and more intensive management, policies that tend to make natural system more brittle and prone to degradation (Gunderson and Holling 2002), rather then policies that embrace the inherent dynamics and scale of the system. Such progressive era legislation as the Taylor Grazing Act of 1934 by creating the allotment process in essence developed a system of property rights for the federally held commons. Yet these holdings, and their privately held counterparts, are usually too small to be economically or ecological viable. This is because they fail to account for the intrinsic variability of the system. Both spatially and temporally rainfall patterns require management at a much larger scale then has been practiced in the past. Such programs as grassbanks (Curtin 2005) are in essence a step back toward a more communal, open system of management. With efforts such as the Malpai Group are a first step toward redefining the grazing associations of the 19th century where collaborative approaches to grazing were promoted (Remley 2000, Curtin 2002).

Of the first 400 years of grazing on the North American continent, successful long-term approaches were sustained for much of that period through the Spanish Land Grant System in which pastoralists communally grazed land grants that were typically long and relatively thin (Spicer 1962, Remley 2000). The spatial configuration of Spanish Land grant maximized heterogeneity and reliance in the face of environmental variability. It is perhaps no accident that these Spanish approaches appear to have their roots in Africa with the Moors from North Africa influencing Iberian grazing practices. For the ranchers of the Malpai seeing the Maasai's open-grazing systems reinforced the necessity of developing more open and resilient grazing systems, and yet these practices that are all but impossible under current US land-tenure systems. This highlights the potential need for reforms in approaches to grazing in North America. For the Maasai, the almost intractable costs of sedentarization become apparent. The key message being that any system of private property rights that evolves on their lands must account for the intrinsic variability in the system. The current Maasai grazing practices recognize these limitations, but increasingly rural "improvement programs" such as water pipelines are encouraging a more sedentary life style that is already leading to profound social change and extreme land degradation.

Turning Liabilities to Assets: Changing the Outcome of Human – Wildlife Interactions.
Throughout its history much of East African conservation rather than serving to sustain local communities and their ways of life, have become the last bastion for imperialism. In recent decades Maasai have gone from considering wildlife their "second cattle" that sustaining their communities in time of hardship, to considering them "white man's cattle" and a symbol of government oppression. Wildlife often represent a real threat to lives and livelihoods, yet are protected from management by the local people (Western 1997, Nelson and Ole Makko 2005). It has often seemed to local people that wildlife were more highly valued then people. Similar processes are at work in the American

West where the discovery of a threatened or endangered species on your land is often not a cause for celebration, but of panic (Figure of Endangered Species from Idaho). For with the designation of critical habitat threats from government, real and imagined, inadvertently encourages an approach dubbed the three S'es or shoot, shovel, and shut-up. Until recently there have been few opportunities for rewarding land managers for good stewardship, or to compensate them for their efforts on behalf of wildlife. These problems are beginning to be recognized and addressed. In the US "Safe Harbor" agreements have reduced some of the risk of promoting or restoring rare or endangered species by protecting landowner from liability if listed species populations later decline. While across the borderlands and elsewhere HCPs (Habitat Conservation Areas) has been developed to recognize the risks associated with actively managing for listed species and to protect land owners from liability associated with change or large scale management actions such as the reintroduction of fire. Research also can play a role. One ranch in the borderlands imported prairie dogs and has been investigating their ecological effects in an effort to demonstrate that conflict is not inherent between prairie dogs and ranching. The initial results are promising with data over the first five years of the study illustrating that prairie dogs can actually provide benefits to ranching at least as tangible as they are for conservation (Curtin 2005b).

Though legal and scientific inroads have been made to change the relationship between wildlife and pastoralists, with the exception of some hunting guide services for mountain lion and other trophy animals borderlands ranchers and others across the West have not as yet developed the kinds of direct economic benefits from wildlife that have come to dominate the African experience (Western 2000, Nelson and Ole Makko 2005). In the face of changing beef markets and increasing land values alternative and higher returns on economic uses of land are likely to be a key facet of preserving open space in both East Africa and North America.

Selling Your Shadow: The role of ecotourism.

At Shampole in the southern Rift Valley a Maasai elder stated that wildlife viewing was "like selling your shadow, sell one and another comes along". One of the principle differences between the approaches on the different continents is the reliance and interest in ecotourism in East Africa. In the visit to Kenya the ranchers and their collaborators witness a range of jointly-developed ecotourism projects that are proving key to preserving Maasai communities and culture in the face of economic and globalization forces. This support for Maasai communities also has profound implications for biodiversity because increasingly wildlife are found on community lands (Western 2000, Nelson and Ole Makko 2005). For their part, the Maasai where struck by the lack of formal tourist activities in borderlands ranching communities. They were baffled by a system where expensive pick-up trucks and intensive fences and water developments cannot possibly be supported by income from livestock alone. Where families go to town to find work off the ranch, rather then looking to the land to provide additional sources of income. A key lesson being that to sustain working landscapes and their associated communities, that ranchers will need to look beyond the cow to sustain their way of life. While going to town is one solution, revenues from diversified land-use could dwarf

cattle-related or incomes and reduce the need for going to town to subsidize a ranching lifestyle.

Livestock Management:
At any meeting of two cattle cultures much of the talk revolves around livestock. Insights into livestock management were another major area of common ground between the participants. In their visit to the United States the Maasai were amazed by a system in which the dogs were pets and stayed inside with the family each night, while the cattle were left outside to fend for themselves. In contrast the Maasai know each of their cattle by name and invest a great deal of time in managing the health of their animals. Maasai cows are brought into the boma each night where they can be looked after, while the dogs stay outside to protect the family and their cattle. While touring borderlands ranches the Maasai's knowledge of cattle was impressive. They could pick-out potential medical issues in cows seemingly at a glace, and on a number of occasions expressed concern for a individual cow's welfare. In contrast to the Maasai who always accompany their cattle and constantly monitor their health, the Western approach to livestock management is much more hands-off and even cows with young calfs frequently must fend for themselves. The experience of watching Maasai with cattle illustrates the indirect costs of the economic structure of industrialized countries were pay scales make such attention to individuals prohibitive. And yet the Maasai approach illustrates the point of how important closer, more intensive management of cattle might be to increase herd productivity.

A key difference between the approaches to livestock management is that the Maasai primarily raise milking cows, whereas ranchers in the United States primarily raise their cattle for beef. As the Maasai move toword more of a market economy cattle, better carcass characteristics (i.e. better meat production) will probably become increasingly important because cattle markets are an important potential source of income and protein. Better use of livestock science such as is developed at US universities could be of assistance in helping the Maasai improve the genetics of their cattle. At the same time the Maasai cattle are superbly adapted to their environment and the US ranchers were quick to point out the folly of having cattle that were great at beef production, but poorly adapted to arid ecosystems (S. Goodloe, Pers. Com. 2004). Here again the United States experience is instructive. For much of the history of grazing in the southwest ranchers used Corriente and other Mexican cattle that are related to the original breeds brought over by the Spanish. Though small and having relatively little meat, these animals were relatively hardy in drought situations. In contrast US ranchers starting in the late 1800s brought over "blooded" cattle primarily related to breeds developed in the relatively cool and moist climates of England. Angus and Herford breeds though having much more meat per animal, cannot survive long away from water and are not drought hardy. These animals tend to bunch-up around water sources and this behavioral characteristic coupled with heavier weights mean these animals are harder on the land. Degradation associated with grazing since the inception of large-scale US ranching in the 1880s is likely in part a result of this preference for British breeds of cattle. The evolving solution in US rangelands has been development of cattle that are "long in the ear", this means that they have a proportion of Brama genetics that makes them more hardy and easier on the land.

Yet this ecologically sound practice comes at a price because cattle with non-british genetics often receive lower prices at auction then the pure breeds. Thus the use of environmentally damaging cattle is institutionalized in the economics associated with the US meat and packing industry.

A major insight the Maasai provide US ranchers is the value of communal grazing systems. By collectively herding their cattle and moving them across the landscape individual owners are better able to avoid localized drought. But perhaps more important is the ability to track the richest grass to attain the nutritional bonus that wildlife attain by following new growth (Western 1997, _____). This mobility can also reduce the impacts of grazing on the land. Communal grazing approaches have the additional potential benefit of promoting more consistent grazing practices and stock genetics. This can make it easier for ranchers to develop niche markets that allow for higher prices for cattle. At present the very different grazing practices and genetics ranch to ranch mean that developing a regional niche market is all but impossible because each ranch has too few cattle to sell on their own, yet each ranch's cattle are too variable to develop consistent alternative markets. Thus communal approaches to management have important economic and ecological implications for North American ranching efforts as ranchers transition from livestock producers to land stewards these alternative approaches become increasingly relevant.

"Live by the sword, die by the sword": The Implications of Science in Community-based Conservation.

One of the hallmarks of rancher-led conservation programs in the borderlands has been a reliance on peer-reviewed science (Curtin 2002, Curtin 2005). As former Malpai Borderlands Group Co-director John Cook stated early in the project "live by the sword, die by the sword". The sense being that though the results from science projects would not always be what the ranching community wanted to hear, a foundation in science was essential for restoring and sustaining the landscape, and in giving the borderlands ranchers the credibility to tackle other conservation issues. In the decade since the MBG formed this approach has served them well. Ranchers still strongly support the science program. Thought it provides them little in the way of direct, short-term benefits the increased understanding of the landscape and the effects of processes ranging from drought, to grazing and fire provides ranchers a context for more effectively applying their own management programs (Malpai Ranchers Wendy Glenn and Bill McDonald, Pers. Com. 2005). In contrast to what one might expect, the ranching community prefers a more basic science program that gives them insights into the major processes at work, rather then one that address specific management issues.

In East Africa science programs are as, or more extensive, then those in the borderlands. Especially in the Amboseli ecosystem more than 30 years of data exist on wildlife abundance and distribution (_____). Yet local communities do not seem to have the same sense of ownership they do in the Malpai borderlands, even though more Maasai are probably directly engaged in the Amboseli research then programs in the borderlands. In the borderlands research programs were established through a series of joint discussions between the ranching and science communities (Curtin 2005). A lesson

for the Maasai is the important role science can serve as a "community-building tool" providing not only a means to acquire knowledge and credibility, but also a forum by which to bring diverse groups together to find common ground. A key insight from the Malpai experience is the importance of engaging local communities in the original science planning process. Even if they are not directly involvement in the research itself, the opportunity for access greatly changes the context in which communities view science.

Conservation Easements:
When the Malpai Group was formed in the early 1990s core issues were the use of fire for habitat restoration and more sustainable cattle markets (McDonald 1995, Curtin 2002). Yet since the Groups founding land subdivision pressures have arrived in the borderlands. Previously subdivided land that sat vacant for decades was suddenly acquired and built-on by a population increasingly drawn to open-spaces, while some neighboring ranches were divided-up for house lots. The borderlands ranchers recognized that the process of subdivsion and the development of "Ranchettes" weas more than just a transfer of ownership. It was a fundamental threaten to the very fabric of their way life and the function of their ecosystem. They recognized that fire was essential to restoring the mosaic of habitats across the landscape and in keep grasslands free encroaching shrubs. But that only a few in holdings covering a small fraction of the landscape could seriously jeaprodize their ability to manage with fire (Curtin 2003). A process all too common in other regions of the southwest where management paralysis associated with residential inroads into wildlands prevents appropriate land management and is increasingly leading to shrub encroachment, erosion, declines in biodiversity, and catastrophic fire events (_____). To combat these pressures the Malpai Group and collaborators have increasingly focused on Conservation Easements to protect open space in working landscapes. Over the last decade over 42,000 acres have been conserved, in addition to over 300,000 acres conserved by The Nature Conservancy on the Gray Ranch.

The use of these conservation tools represent an important alternative to the traditional institution of parks are other preserve areas. They create win-win situations in which the majority of management costs are sustained by the local community and their funders reducing costs to land management agencies, while local communities retain access and control of their historical lands. In the borderlands is has been estimated that if these lands were managed as traditional parks of preserves the management costs would be some 20 times those current encountered through the existing interaction of federal, state, and private mangement. This approach has huge implications for East Africa where wildlife are increasing found outside of parks, and where the parks are unlikely to ever be large enough to protect the grasslands at the scaled needed to preserve their functional attributes. The North American experience with Conservation Easements and related strategies is particularly instructive in the East African context. It provides another tool by which private sector conservation initiatives can become established and a means of transferring conservation dollars to tangible stewardship on the ground.

Summary:
The interaction of Maasai and borderlands ranchers highlights the ubiquitous nature of many conservation problems. A comparison of the issues facing the respective cattle-cultures illustrates that some much of conservation is about getting the scale right, and that getting the scale right is typically as much or more a socio-economic as a biological problem. It is increasingly hard to distinguish issues of social justice and economic sustainability from those of the preservation of biodiversity and ecosystem structure and function. In both East African and Southwestern rangelands preserving culture and ecology are interlocked. With virtually all issues from preserving land-tenture systems to developing effective science programs hinging on developing effective socio-economic systems, while resting social action on a firm foundation of the best available, peer-reviewed science.

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Appendix II.

Final Report to the Community-based Collaboratives Research Consortium
November 30, 2005

Assessing the Adaptive Capacity of Collaboratively Managed Rangelands: A Test of the Concept and Comparison of 3 Rangeland CBCs

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Abstract

The aim of this project was to develop a conceptual framework and analysis tools to assess the adaptive capacity of community-based collaborative groups (CBCs), to test these tools by applying them to three rangeland collaboratives, and to identify factors that contribute to the adaptive capacity of CBCs. We developed a conceptual framework for assessing the adaptive capacity of CBCs and used this framework to guide development and implementation of a quantitative survey to assess the adaptive capacity of three rangeland CBCs, the Malpai Borderlands Group, the Diablo Trust, and the Northwest Colorado Stewardship. We also constructed in-depth qualitative case studies of each group's adaptive learning process following our framework. Eight factors that affect adaptive capacity were identified: a holistic approach that embraces complexity, commitment to learning and monitoring, vertical vs. horizontal decision-making structures, financial and other resources, trust, bureaucracy, linkages with and awareness of the broader social-ecological context of the CBC, and finding the appropriate social and ecological scale. This report concludes with eight recommendations for enhancing the adaptive capacity of CBCs.

Introduction

Assessing the socio-ecological outcomes of community-based collaboration has proven a persistent challenge both at the scale of self-assessment by individual CBCs, and at scale of evaluation and generalization across multiple collaborative efforts. Self-assessment of socio-ecological outcomes by individual CBCs is often hindered by lack of funding and technical expertise in ecological and socio-economic monitoring, as well as waning interest and participation in volunteer monitoring activities (Fernandez-Gimenez and Ballard Forthcoming). Studies that seek to generalize about the environmental outcomes of collaboration by studying or comparing many groups are faced with significant methodological challenges, due in part to the unique history of each CBC, its goals, socio-economic and political contexts, and the environment it stewards (Brogden 2003, Conley and Moote 2003). This variation, in turn, makes it difficult to establish cause and effect relationships between collaboration and environmental outcomes, and to compare among groups with differing management objectives and strategies. Further, there is often a significant time lag between the implementation of management and the occurrence of detectable ecological change. This is especially true for some practices aimed at restoring degraded ecosystems. Thus, it may be too early, in many instances, to detect long-term ecological impacts of collaborative stewardship. In addition, environmental problems that CBCs attempt to address may be influenced by stressors beyond their control. For all of these reasons, some critics challenge the conceptual soundness and utility of external evaluations of CBCs' environmental outcomes based on predetermined criteria (Moseley 2003).

In natural resource management there is a growing realization that past "command and control" approaches to resource management, while sometimes effective in the short-term (years to decades), are often disastrous in the long-term (decades to centuries) (Holling and Meffe 1996). For example, fire suppression in many North American forests was effective in the short-term, but has led to forests whose stand structures and fire regimes are now far outside of their historic range of variation, resulting in catastrophic wildfires of greater intensity and extent than historically occurred in some forest types. Holling and Meffe (1996) proposed a new "golden rule" for resource management: "Natural resource management should strive to identify and retain critical types and ranges of natural variation in ecosystems, while satisfying the combined needs of the ecological, socioeconomic, and institutional systems" (Meffe et al. 2002)p.66). In other words, rather than trying to control natural variation, we should strive to understand and maintain it. Two important concepts associated with this approach are *resilience* and *adaptive capacity*. Resilience refers to a system's capacity to retain its essential structure and function in the face of change or stress (Walker et al. 2002). (It is important to note, that resilience is not always a desirable quality. If the system in question is in an undesirable state, resilience can make it very difficult to restore or change it to a more socially desirable configuration.) Adaptive capacity is the ability of a system to "learn, experiment and foster innovative solutions in complex social and ecological circumstances" (Armitage 2005), p.703-704). Simply put, adaptive capacity is the ability to respond positively to change. In line with the golden rule proposed by Holling and Meffe, Walker et al. (2002) propose that natural resource managers focus on "managing for resilience" of social-ecological systems. A critical aspect of this approach is adaptive management (Holling 1978, Walters 1986), which

approaches natural resource management as an opportunity to learn by doing, applying the scientific principles of experimental design to the implementation of management actions on the ground. Since ecosystems (including social systems) are complex and knowledge about them is incomplete, adaptive management structures management actions to yield the reliable and accurate information about management effectiveness, while positioning managers to learn from the inevitable surprises and uncertainties of complex systems. Armitage (2005), relates adaptive capacity broadly to community-based natural resource management, suggesting specific factors that influence adaptive capacity in community-based natural resource management.

In view of the challenges to assessing environmental outcomes of CBCs, and the growing awareness that system resilience and adaptive capacity may be the most important determinant of long-term social and ecological sustainability, we propose an alternative to assessing actual environmental outcomes of CBCs. This approach focuses on CBCs' capacity to learn from the social-ecological system and from their actions, and to apply this learning to improve stewardship. Now the question is not: what are the environmental and social outcomes? Rather, it is: does the CBC have a process in place through which to experiment with management, monitoring social and environmental changes (outcomes), and apply new information to improve stewardship? The assumption behind this focus is that monitoring in an adaptive management context will lead to improved management and ultimately, improved environmental and socio-economic conditions. Well-designed long-term monitoring will also help to answer the underlying question in the long run: What are the environmental and social outcomes of collaboration? Thus monitoring and adaptive management set the stage for learning, long-term evaluation of social-environmental outcomes, and successful adaptation and resilience in the face of environmental and social uncertainty.

Objectives

The overall goal of this project is to test the concept of adaptive capacity as an evaluation criterion for community-based collaboration in natural resource management. Our specific objectives were:

1. Develop a conceptual model of adaptive capacity in CBCs.
2. Develop and test an analytical framework for comparing adaptive capacity among CBCs, including both qualitative and quantitative assessment tools.
3. Document the collaborative learning processes and indicators employed by 3 rangeland CBCs in order to assess and compare their adaptive capacity.
    a. Conduct a qualitative cross-case comparison
    b. Conduct a quantitative cross-case analysis
4. Analyze the factors that contribute to enhanced or diminished adaptive capacity in the three rangeland CBCs compared.
5. Identify robust criteria and indicators for assessing the adaptive capacity of CBCs

Methods

Conceptual Model and Analytical Framework

Our conceptual model of adaptive capacity in community-based collaboratives was developed based on the existing literature on resilience and adaptive capacity, community-based collaboration, and criteria and integrated indicators for sustainability.

The main structure of the model is designed according to three stages that reflect the cyclical process of learning and adaptation of CBCs: definition, implementation, and evaluation stage. Based on this overall conceptual model, a more refined analytical framework was developed that identified specific qualitative and quantitative evaluation criteria for each stage of the conceptual model. Since this conceptual model guided the development of our quantitative and qualitative assessment approaches, described below, we present it here, rather than in the results section.

Our conceptual model of adaptive capacity is shown in Figure 1. The adaptive cycle described by our model is divided into three chronological stages. The definition stage describes the structural and functional characteristics of the CBC at its inception, and their later modifications through the cyclical process of learning and adaptation. Structural characteristics include the biophysical environment, the socio-economic and political contexts of the CBC, spatial and temporal scales addressed by the group, the number and kind of participants, and linkages between the CBC and other levels of social and ecological organization. The functional characteristics include the type and quality of decision-making processes generally, and natural resource planning and monitoring processes specifically. The implementation stage describes the management actions taken, their social and ecological outcomes, and the monitoring conducted to document outcomes. The reflective stage describes the formal and informal feedback mechanisms for evaluating and acting upon learning from outcomes and monitoring. Within each of these stages of the learning and adaptation cycle, the analytical framework attends specifically to CBC participants' changing awareness of the potentials and limitations of the social-ecological system. Although the three stages of the model reflect a roughly chronological sequence of organizational development, we recognize that in reality, many (if not most) groups will be engaged in aspects of several stages simultaneously. Since the model is cyclical, we also expect that the learning that occurs in the implementation and reflection stages will lead to actions and resulting changes within those stages, in the structure and function of the CBC, and in the social-ecological system of which it is part. Indeed, the aim of most CBCs is to foster such changes in both environmental and social (community) conditions.

ASESAC Survey

Our original intent in this project was to focus primarily on a qualitative assessment of adaptive capacity relying on in-depth case studies of each of the three study CBCs. However, several of the team members had experience developing quantitative instruments for assessing sustainability indicators (Aguilar 1999). We applied similar methodology to develop and test a survey to provide a quantitative assessment of the adaptive capacity of CBCs. The use of this quanitative tool provided a means to triangulate our qualitative data collection and analysis, and helped highlight potentially significant differences and similarities among the CBCs studied.

The survey tool, which we refer to as the Assessment of Socio-Ecological System Adaptive Capacity (ASESAC), follows the structure of the conceptual model and includes indicators that serve as evaluation criteria for each of the chronological stages. Points were distributed and weighted for each section and indicators reflect the importance of each in relation to adaptive capacity. The total number of points in the survey is 2000. Of this total, the distribution of points for each of the stages is as follows:

600 points for the definition stage, 600 points for the implementation stage, and 800 points for the evaluation stage. The evaluation stage received more points than the other two stages because it includes indicators of feedback mechanisms, which are critical to the overall definition of adaptive capacity. Table 1 shows the distribution of points among the different categories and indicators for each of the stages, weighted according to the importance of each to adaptive capacity.

Based on this framework, we developed a survey that includes multiple questions for each of the stages and categories. Questions were divided among descriptive and evaluative criteria, with each evaluative question within each stage receiving an allocation of the points from the total of points in that stage. See Appendix A. for a copy of the survey instrument. Each question was evaluated with a six-point Likert-like scale with responses ranging from strongly disagree to strongly agree, and the most favorable response receiving the highest score. Initial drafts of the survey were reviewed and pilot tested with other researchers familiar with the subject CBCs but not directly involved in this research effort. Several revisions were conducted to ensure that survey items accurately reflected the underlying concepts.

Survey Implementation

The ASESAC survey is designed to be used by researchers studying or working in partnership with a community-based collaborative group. The questionnaire should be completed by a researcher or research team based on their knowledge of the group. This expert knowledge may be based on direct observation, other primary data (ecological field samples, social surveys, project documents, etc.), and direct input from CBC members or observers. For evaluation questions, we recommend the research team use a Delphi (or modified Delphi) procedure (Linstone and Turoff 1975, Kastein et al. 1993). The Delphi procedure refers to an "expert judgment" where the validity of the resulting judgment of the entire group is typically measured in terms of the explicit "degree of consensus." Depending on the size of the research team, degree of consensus may be a complete consensus or a majority process.

In this project, the survey was completed by research team members with close working relationships with each of the subject CBCs. For the Diablo Trust, Munoz-Erickson and Aguilar-Gonzalez completed the survey using a Delphi procedure. Another member of the research team completed the survey independently and the overall responses were modified to reflect the views of the third team member, who had the longest experience with the group. For the Northwest Colorado Stewardship, Fernandez-Gimenez completed the survey together with two other researchers with two years of direct knowledge and experience with the group using a consensus Delphi approach. For the Malpai Borderlands Group, Curtin completed the survey alone, based on over a decade of close observation of the group.

Data Analysis

We used an Excel spreadsheet to calculate the scores for each of the individual questions, section categories, and stages. The individual question score for each case study was entered in the spreadsheets and all points were added. We then calculated a percentage of the points received for each section out of the total number of points allocated (600, 600, and 800), and then a final percentage out of the total points for all

stages combined (2000 points). However, scores were calculated only out of the items that were completed. Thus items that did not apply to a particular CBC were not counted "against" the group. The resulting data were summarized with vertical bar graphs.

In addition, we assessed the vulnerability of the survey to observer bias by conducting a correlation analysis. We used Correlation Analysis (SPSS v 12.0) to test the strength of the correlations between the scores of the three different case studies and assess the robustness of the survey in minimizing observer bias. We also did this in order to test the possibility of bias from interactions among members of our research team, as we thought that information-sharing among team members might have resulted in members influencing each others' responses. We conducted four different tests correlation analyses using the scores of the ASESAC survey: 1) analysis of the points scored per stage; 2) analysis of overall individual scores; 3) analysis of points scored per stage broken down per section of the questionnaire (definition, implementation, and evaluation); 4) and, analysis per individual score and per stage. The first and second tests sought to gauge the biases at two different levels of aggregation (scores per section and individual scores on any section). Since the collaborative organizations studied are at different stages on the adaptive cycle, the third and fourth seek to identify differences between the stages in those potential biases.

Qualitative Analysis Approach

We developed descriptive case studies for each of the three subject CBCs following the conceptual model and analytical framework developed in the first phase of the project. The case studies were constructed from researchers' responses to the descriptive questions in the ASESAC questionnaire, and supported by existing literature, documents, survey results, monitoring data, and participant observation. The purpose of the case studies was to allow for a more nuanced and complete narrative description of each group's collaborative learning process, and its apparent adaptive capacity. The case studies are used in our analysis and discussion to help explain the similarities and differences in adaptive capacity among the groups, as well as to identify and highlight other emergent findings that may not have surfaced using the quantitative survey alone. These descriptive case studies, when compared with the results of the quantitative survey analysis, also point to the strengths and weaknesses of a quantitative approach to assessing adaptive capacity.

Results and Discussion

Accuracy and Utility of the ASESAC Survey

Validity Tests of the ASESAC Survey

For the first test, analysis of the points scored per stage for each case study, we found a significant correlation between the score for the Diablo Trust and the Malpai (ρ = .901, $p<0.01$), a significant correlation between Malpai and NWCOS (ρ =.793, $p<0.05$), and no significant correlation between the Diablo Trust score and the NWCOS score (ρ = .750, $p>0.05$). This may indicate that a bias exists and that the perceptions of the evaluators on the aggregate level of the Diablo Trust and NWCOS are influenced by the Malpai borderlands evaluator. When this potential aggregate level bias is scrutinized by

measuring the correlations in the aggregate scores between stages (test 3) we found no evidence of significant correlations.

For the second test, analysis of individual scores, we only found a significant correlation between the scores for Malpai and NWCOS ($\rho = .258$, $p<0.05$), suggesting a potential bias between Malpai and NWCOS. Nevertheless, the analysis of individual scores per stage revealed no significant correlation (test 4).

To summarize, the results from these tests indicate that at the level of final scores for each group, we are seeing similarities in responses that could be indicative of observer bias. However, when each section of the questionnaire is analyzed in detail, the lack of significant correlations among the groups indicate that there is no overlap among observer responses, therefore there was little influence between the members of this research group in how they answered the surveys. The correlation we are observing in the final group scores may a result of similar perceptions toward the groups but they are different in each of the evaluative criteria.

Strengths and Weaknesses of ASESAC Survey Instrument & Implementation

Implementation of the survey and analysis of the results led to the recognition of a number of potential limitations of our survey instrument and its implementation. In this section we discuss potential limitations, how they were addressed, and our recommendations for future modifications in the survey instrument and implementation process.

First, as with any survey, there is the question of whether all respondents interpreted the questions in the same way (internal validity). For example, different researchers may have rated their CBCs differently depending on whether they were comparing the CBC's performance with an "ideal type" CBC, with the CBC's own potential, or with status-quo agency management. Similarly, different respondents may have different ideas as to what constitutes an "adequate" system model. This flaw could be addressed by clarifying the standard for comparison in the survey instructions.

Second, the potential exists for the stage of the CBC's development to influence how it is evaluated on certain criteria. We accounted for this to some extent by calculating each group's score only out of those items completed for that group (rather than all items), thus not penalizing a younger group that had not yet reached the evaluation stage. However, we also recognize that the stage of development may influence certain group characteristics, and thus the evaluator's perception of the group's performance. For example, at the time of the survey, many NWCOS participants were not satisfied with or hopeful about the group's progress—a function of the group's stage of organizational development. Similarly, some of the DT researchers rated the group lower on certain criteria than another DT researcher with a longer history with the group. The differing perceptions of the group's performance were based on the CBC's status at the time the researchers began their work with the group. We note that in our study, researchers with a long history with a group tended to rate the group more positively than researchers with a shorter history with the CBC.

Third, a related issue is the role of the researcher within the CBC. We call for the ASESAC to be completed by a knowledgeable researcher working in partnership with a CBC. However, some researchers see themselves or are seen by CBC members as group participants as well as (or more than) observers, while others maintain more of an

"outsider" status. The potential exists for the researchers' role in the group to influence her evaluation of the CBC.

Fourth, an important indicator in the definition stage was the existence of a comprehensive management plan, yet two of the three CBCs studied (MBG and NWCOS) did not have such plans. Thus, these questions were either left blank ("not applicable") or were interpreted to apply to activity- or project-level plans (e.g. a fire plan or fuels treatment plan) rather than comprehensive management plans. This may have resulted in a more positive rating for the MBG and NWCOS than if the indicator had been strictly interpreted.

Fifth, some members of our research team felt strongly that research should be included as an indicator distinct from monitoring, since research allows for deduction of cause and effect relationships, and can account for multiple interacting factors, leading to more powerful learning than monitoring.

Sixth, it is desirable to have more than one researcher complete the ASESAC survey for each group, or for multiple researchers to complete the survey together using a modified Delphi approach. In our pilot test, the survey was implemented differently for each group (see methods section), potentially influencing the validity of our results.

Comparing the Adaptive Capacity of 3 Rangeland Collaboratives

Quantitative Comparison

Table 2 presents a summary of the survey results. Overall, the MBG had the highest adaptive capacity score (77.5%) according to the ASESAC survey, compared to the DT (56.6%) and NWCOS (56.1%). The MBG score is attributable to uniformly high scores in each subsection of the assessment tool. All groups received relatively consistent scores on each subsection completed for that group. (DT and NWCOS did not complete the evaluation stage subsection, because they have not reached that stage of development yet.) However, there was less consistency within each stage. Within the definition stage, DT was weakest in its structural characteristics and strongest in its functional characteristics, while MBG was strongest in its structural characteristics and weakest in recognizing system potentials and limitations. NWCOS had strong functional characteristics, but was also very weak in its recognition of system potentials and limitations. The strength of NWCOS' functional characteristics is due primarily to its democratic and inclusive process and the supportive involvement of key agencies. Similarly, DT has an inclusive and participatory process, as well as a program/landscape-wide management plan, which was created through highly inclusive process. MBG was evaluated as having an inclusive process with strong supporting agencies, clear management and monitoring plans and resources to implement them. MBG strength in its structural characteristics was due to the breadth of stakeholder participation and a strong system model.

In the implementation stage, both DT and MBG received their highest scores for process evaluation and outcomes, with lower scores (relatively) for monitoring tools and recognition of system potentials and limitations. DT scored particularly low in the latter category. In contrast, NWCOS received its lowest score in process evaluation (due to participants' current dissatisfaction with the process) and monitoring, and its highest scores in outcomes and recognition of new system potentials and limitations. Overall, NWCOS performed better in the implementation than the definition (planning) stage, and

demonstrated the greatest level of learning as reflected in the 20% rise in the score associated with recognition of potentials and limitations between the definition and implementation stages. The poor performance of the DT in the recognition of potentials and limitations may be due to the extended and frustrating NEPA analysis on their management plan for US Forest Service lands that occurred during this stage. Only the MBG is sufficiently advanced to provide responses for the evaluation stage, so no comparison among groups is possible for this stage.

Overall, all groups performed better in implementation of management actions than in monitoring of outcomes. MBG and DT were strongest in process evaluation in the implementation stage, while NWCOS managed to accomplish implementation and monitoring despite low stakeholder satisfaction with the process. With respect to outcomes, MBG performed well on ecological and organizational indicators, but not on social indicators. DT performed at a moderate level in terms of ecological indicators, and most social and organizational indicators, but poorly in terms of the vigor of the social-economic system and well in terms of the group's own vigor. NWCOS performed moderately well with respect to all organizational indicators and the diversity of the biophysical base, but less well on the other ecological and social indicators.

Qualitative Comparison

Detailed case studies of each group are available in appendices B-D. Case summaries are found in Table 3. The three rangeland CBCs analyzed are similar in their underlying ecological and land use contexts. All are located in semi-arid to arid rangelands where the dominant traditional livelihood has been ranching. Driving ecological variables at all sites include precipitation, grazing and fire. The MBG and DT areas are experiencing some pressure from exurban development, while such pressure remains minimal for NWCOS, both because of its remote location and exclusively public lands context. Both DT and MBG were initiated by ranchers in the late 1980s and early 1990s. DT adopted an open membership and actively recruits diverse participants, primarily from the Flagstaff area, while MBG remains a group of ranchers who work in close partnership with agencies and conservation NGOs. NWCOS was organized more recently (in 2003) and has not yet incorporated as a non-profit. The group has an open membership with a wide range of stakeholders participating. NWCOS and DT both use consensus-based decision-making, while MBG has been described as a more hierarchical organization in which the executive director or a small group of board members and staff make most key decisions. NWCOS is facilitated by an outside facilitator while DT's meetings are run by members. MBG and DT share very similar mission statements that encompass both ecological and community health, while NWCOS' mission is broadly to improve decision-making on public lands through collaboration. Interestingly, the NWCOS mission statement aspires to "shared values" but nowhere articulates what these are. In contrast, MBG and DT both explicitly value "healthy unfragmented landscapes" and "diverse and flourishing" human, animal and plant communities.

Each of the study CBCs developed an explicit system model (or models) at some phase in its development. System models, qualitative conceptual models that illustrate the relationship among key ecological and social factors and processes, document shared understanding of social-ecological systems, identify uncertainties and conflicting perceptions, and serve as a basis for identifying potential management strategies and

monitoring indicators. The models created by the study CBCs varied in how they were created and used, and their degree of comprehensiveness. The DT model is the most comprehensive and integrative, but was developed by cooperating researchers to provide a conceptual framework for developing sustainability indicators. The DT membership informed and approved the model, but did not directly participate in creating it (Muñoz-Erickson and Aguilar-Gonzalez 2003). The MBG model focuses on ecological variables exclusively, and was developed by group members and scientists in a workshop (Curtin 2005). This model was a formalization of an implicit system model that many group members and scientists held. NWCOS members created a series of models that included a wide range of social and ecological variables as part of a workshop on adaptive management for OHV use. These models were never consolidated into one comprehensive model, and but most of them included similar variables and relationships. The group also developed a model that related seral stages of vegetation to fire frequency as part of another workshop. This model was used to develop desired future conditions and a fuel treatment plan for one grazing allotment.

As mentioned earlier, only DT has a comprehensive natural resource management plan that covers its entire area of influence. NWCOS is participating in the revision of the BLM area management plan, and has developed project and activity level plans for fuels treatment and OHV monitoring. MBG has a programmatic fire plan, and a habitat conservation plan, but no overall natural resource management plan. We uncertain of the importance of having a holistic management plan versus several project or activity-level plans for a group's adaptive capacity. Early empirical evidence from many case studies of CBCs suggests that collaborative groups should take a holistic and integrated perspective on defining problems (Wondolleck and Yaffee 2000). In this project, we emphasized the importance of a holistic conceptual model of the social-ecological system to the adaptive capacity of CBCs. It follows that a management plan should be similarly holistic. Nevertheless, the MBG, which ranked highest among our case studies in our quantitative assessment of adaptive capacity lacked a comprehensive and adaptive management plan.

All groups have implemented on-the-ground actions which have resulted in assumed or measured ecological and social outcomes. The MBG has affected the largest land area through a program of conservation easement acquisition and the reintroduction of prescribed fire on some 200,000 acres. DT has implemented fuels and habitat improvement projects on approximately 80,000 acres of private and AZ state lands, but has thus far been unable to implement new management on US Forest Service grazing allotments due to delays in NEPA analysis of their management plan. NWCOS has carried out one habitat improvement project on one grazing allotment.

Changes in knowledge, attitudes and relationships are more difficult to document and measure, but all 3 CBCs have demonstrated changes in at least some of these areas. Through the involvement of CSU, NWCOS members have learned about adaptive management and monitoring, and through their participation in the RMP revision process, they have also learned a great deal about the challenges of the BLM's planning process. While new relationships have been established through the collaborative process, it is not clear how strong they are, and a survey of NWCOS members indicates that trust little trust has been built among members, although collaboration and communication skills have improved. DT has had a number of effects on the social and

political aspects of its community, and has invested significantly in public outreach and education. Although trust and relationships within the group were severely strained by the protracted NEPA process on the group's management plan for its Forest Service lands, the group persisted and has recently been reinvigorated by its involvement in developing a plan for one of the first Rural Planning Areas in the state of Arizona and receiving a final decision from the Forest Service on their Environmental Impact Statement that will let them move forward with most of their initial management goals. MBG started with a small group of neighboring ranchers who slowly built trust with partner agencies and conservation organizations, as well as a widening circle of ranchers in the area.

In the implementation stage, all three groups have experienced some level of delay or frustration in planning or implementing management due to regulatory hurdles from NEPA or ESA or both. The delay for DT has been particularly prolonged (about 10 years). The MBG eventually succeeded in gaining approval for its programmatic fire plan, despite concerns about impacts on some threatened or endangered species, in part because its science program was able to demonstrate that harmful impacts were minimal to the species of concern. Although NWCOS does not yet have a management plan, it is currently in the throes of the BLM RMP planning and EIS process. This bureaucratic planning and assessment process has commandeered virtually all of the group's energy and attention over the past year and for the foreseeable future, which has undermined its ability to build trust and forge a shared vision for its landscape and communities. Many citizen members of the group are frustrated with the amount of reading and work required. For example, the group was recently asked to review and comment a 1700-page "summary table" of the management alternatives, which prompted at least one citizen member to walk out of the meeting.

All groups also have conducted monitoring, and all have participated in research efforts. DT's monitoring, though still under development, is most comprehensive, involving ecological, social and integrated indicators (Muñoz-Erickson et al. 2005). MBG has extensive monitoring and research programs related to fire and grazing effects, and conservation easements, but has no formal socio-economic monitoring (Gottfried 1999). NWCOS has developed a pilot multiparty monitoring project for OHV use (Bishop 2005) and has participated in research to assess social outcomes of collaboration. All of the groups were strongest in ecological monitoring and research, and weaker in social and economic monitoring. DT has the most developed and integrated monitoring tool, and NWCOS has participated in social research. MBG remains weakest in socio-economic monitoring, although the group recognizes and is seeking to address this weakness.

Despite the interest in and commitment to monitoring in all groups, the links between monitoring (and research) and management remain weak across the board. All groups at this point lack structured feedback mechanisms that link monitoring to evaluation and action. Even the group with the most financial resources and greatest scientific and monitoring capacity, MBG, has resisted linking monitoring data to ranch-level management decisions. Similarly, ranchers in the DT are concerned with data confidentiality and use, but are willing to discuss these issues openly with other members in DT meetings (Muñoz-Erickson et al. 2005). Although NWCOS has not yet broached monitoring on a broad scale, we anticipate that industry participants (both ranching and

oil and gas) will have similar concerns, based on their response to past biological inventory proposals in Moffat County.

Despite the lack of formal or structured feedback mechanism, at least some members of all groups display a philosophical commitment to learning and adaptive management. For example, DT ranchers subscribe to the holistic management principles of Alan Savory, which rely heavily on monitoring. These individuals have independently gathered years of data on their own. Concern remains that agency partners, although supportive, may not accept and use monitoring data collected by the DT, and that there may not be sufficient funding and organizational capacity to carry on long-term integrated monitoring (Muñoz-Erickson et al. 2005). Many NWCOS citizen and industry members are strongly committed to the concept of adaptive management, but are concerned that the BLM lacks the resources to carry out the needed monitoring. BLM participants are less enthusiastic, in part because they are wary of the long-term monitoring commitment entailed by adaptive management. MBG recently commissioned a review and synthesis of its scientific research (Sayre 2004b) and a long-term management plan (Sayre 2004a), which point to the need for greater linkage between monitoring and management.

Ecological and Social Indicators

Tables 4-6 summarize the ecological and social indicators and measures used (or proposed) by each of the three study CBCs. Most of the listed indicators are used in monitoring conducted by the CBC or partner researchers. In the cases of MBG and NWCOS, some of the indicators are used by researchers in studies conducted with the cooperation or consent of the group to help better understand ecological dynamics (MBG) or social outcomes of collaboration (NWCOS). DT has the most comprehensive and integrated list of indicators, which were developed expressly to assess the group's impacts on its social-ecological system. Data from these indicators yield important information and implications about assessing the ecological and social outcomes of the DT, and potentially collaboratives in general, but it remains to be seen which of the indicators will be implemented by the group over the long-term (Muñoz-Erickson et al. 2005).

All three groups recognize key ecological indicators that are necessary to address the health of these rangelands, such as the composition, production, and cover of vegetation, abundance of exotic invasive species and invasive native shrubs, and soil quality and stability. As previously noted, the use of social indicators is weak, although at least primary economic indicators of ranching are addressed by two of the groups, MBG and DT, and likewise two groups, NWCOS and DT, addressed organizational indicators. Overall, the ecological indicators used by the three groups are comparable at a basic level, with the main difference being the scale at which data are collected. Comparison of social indicators across the three sites requires greater consistency in indicators among the groups. Greater consistency would provide a better picture of how the social systems in rangelands are changing and the role that CBCs play in mitigating or adapting to this change. Since the DT has the most developed and integrated set of indicators, its integrated monitoring protocol may serve as a model or "menu" from which other CBCs might select key social and economic indicators to apply in their areas.

Implications

Factors Affecting the Adaptive Capacity of CBCs

Adaptive capacity is an attribute of social and ecological systems that describes how systems respond to stress and changing conditions. Systems that are able to adapt to new conditions without losing their essential qualities (structure and function) are resilient systems. Each of the 3 CBCs we studied aspires to maintain essential qualities of its community and landscape in the face of changing demographics, economics, climate, and land-use patterns. In each case, the formation of a CBC can be seen as one mechanism for adaptation within the socio-ecological system. In this section we discuss some of the emergent findings from this study that suggest key factors that may influence the adaptive capacity of CBCs, or which deserve further exploration.

- *Embrace the big picture: willingness to grapple with complexity and uncertainty*

All of the groups studied were willing to embrace the complexity and uncertainty of the socio-ecological systems in which they are embedded. The system models used by the groups served to help group members organize and understand the complex linkages between the social and ecological elements of the system and the processes through which they interact. In some cases, they also helped the group define clear and measurable goals and objectives, and monitoring indicators (NWCOS). In other cases (MBG), the system model helped members reduce the system's complexity to key driving variables that can be measured and understood. While MBG and DT had clearly holistic goals, DT's management plan and monitoring protocols followed through on the holistic approach. In contrast, MBG and NWCOS both pursued more compartmentalized approaches to management, addressing single resources or management issues at a time (albeit, driving issues/processes such as fire in the case of MBG). One of several questions that remains from this analysis is the question of whether a holistic and comprehensive management approach (such as DT's) should be evaluated more favorably than the more compartmentalized approaches employed by the MBG and NWCOS.

- *Commit to learning and monitoring*

All of the groups were committed to learning and to using monitoring and scientific research as ways to learn, even when this entailed risk to individual interests. All engaged in partnerships with scientists as part of this process, which greatly enhanced their capacity to implement monitoring. Yet despite this commitment, all groups lacked structured feedback mechanisms to facilitate learning and action in response to new knowledge. In our assessment framework, we found that documentation of the group's changing perceptions of system potentials and limitations was an effective indicator of learning through the adaptive cycle. However, this was an area in which the groups were generally weak. Since learning, monitoring and evaluation and action based on learning are essential aspects of adaptive capacity, these aspects deserve greater attention from CBCs. In particular, an intentional attitude towards learning, and development of a clear and regular process for self-evaluation and reflection are priorities for enhancing adaptive capacity.

- *Assess the relative merits of vertical and horizontal decision-making*

Our assessment tool and analysis framework operated on the assumption that diverse stakeholder membership and broad and inclusive participation in decision-making are desirable attributes for adaptive capacity. However, we learned that the most effective CBC studied (MBG), has the narrowest membership and most hierarchical decision-making approach. We suggest that vertical decision-making (by one leader or a small group) may be more efficient, and enable a group to accomplish more. The effectiveness of this approach, however, depends on high levels of trust among members, who are willing to delegate authority to the leaders. This worked well for MBG, which is a group composed of ranchers who share similar values, interests and norms. The streamlined decision-making process in MBG facilitated an effective and adaptive group. However, this approach would have been doomed in NWCOS, which is composed of a wide range of stakeholders with opposing interests and few shared values. Although inefficient, engaging a wide cross-section of members in some types of decision-making may promote institutional sustainability (and resilience), since more individuals share knowledge and build capacity in technical areas (such as monitoring), enabling them to take over leadership roles or other key functions. Broad and long-term participation also helps build and maintain institutional memory, and transmit and sustain ecological and social memory of the socio-ecological system. As well, these broader decision-making forums, while slow and often contentious, may ultimately lead to greater trust-building among diverse interests. The experience of DT suggests that more than one decision-making mode can be used by a single group. In the case of DT, a small group may be more appropriate for pasture-level monitoring and management decisions, but the whole group should be involved in the integrated monitoring and evaluation effort.

- *Resources matter*

MBG had a great advantage over the other two groups we studied in its early access to significant outside technical and financial resources. The assistance of high-level Nature Conservancy officials afforded the group tremendous political clout and fundraising capacity, as well as leadership experience and guidance, which helped it achieve its success and notoriety. The extensive resources that the Malpai was able to access are not available to most groups, and make the Malpai a model that cannot be replicated elsewhere simply because of the cost.

- *Trust is the foundation on which adaptive capacity is built*

Although MBG had significant financial and capacity advantages, these advantages do not diminish the investment made by this group in building trust both within its rancher membership, in the larger ranching community in southern Arizona and New Mexico, and among ranchers, conservationists and agency staff. The years invested in front porch conversations led to a foundation of trust that enables the group to delegate decisions and operate efficiently today. Similarly, DT has invested years in gaining a broad membership and constituency of supporters from both urban and rural communities. Together, diverse members forged a shared vision and clear goals and objectives for the DT landscape, and a management and monitoring plan. In contrast, NWCOS members were quickly thrown into a highly political planning process without the opportunity to develop trust or a shared vision for the community and landscape. Very little trust has developed over the group's 2 years in existence and some members doubt whether the

group will be able to reach a meaningful consensus on a community alternative for the BLM resource management plan.

- *Bureaucracy can hinder adaptability*

This study supports the findings other research which points to the institutional barriers to collaboration (Hughes-McDermott et al. 2005, Tilt 2005). For both the MBG and DT, NEPA and ESA posed significant roadblocks to implementation of management, and subsequent learning and adaptation. For the DT, this roadblock negatively affected the trust level between group members and the agencies, which had taken years to establish. This distrust in turn prevented them from moving forward on other aspects of their organization, such as monitoring. NWCOS similarly is recognizing that the institutional structure of NEPA does not easily facilitate adaptive management.

- *No group is an island*

The opportunities for and obstacles to collaboration reach far beyond the immediate social-ecological and organizational context of each CBC. We attempted to control for some of these factors by selecting CBCs in similar environmental settings dealing with similar land use issues and socio-demographic and economic pressures. All of the study CBCs formed largely in response to a combination of changing social values, changing demographics and economic drivers in rural communities, and concern over landscape fragmentation and/or undesirable vegetation changes. Reflective of the larger national, trend, these groups have come to fruition in a political climate supportive (in theory at least) of collaboration in natural resource management, but stingy with funding for public agencies. NWCOS has reaped the benefits of a decade of earlier experiences with collaboration, and had access to agency-sponsored training and willing and committed agency partners that may not have been available a decade earlier. The key point here is that these contextual factors are part of the socio-ecological system of the CBC and must be understood as part of the enabling and constraining environment for CBCs. Adaptive capacity, in turn, is determined in part by how well CBCs understand, interact with, and learn from the larger socio-ecological system of which they are part.

- *Getting the scale right*

Collaboration in natural resource management emerged in tandem with ecosystem management and adaptive management in part because collaboration provides an institutional means for managing across administrative boundaries. Drawing on the lessons of landscape ecology and conservation biology, ecosystem management strives to understand and maintain natural variation in key ecological processes and structures. Managing spatially extensive ecological processes, such as wildfire, in turn requires transcending political and administrative boundaries and scaling management to these driving processes. The same idea applies to the social system, where the definition of community and the scale of the economy determine which stakeholders participate or are affected by the collaborative. For instance, in many rural areas in the West the demographics are shifting from domination by traditional land users (ranchers, miners, loggers), to newer populations that use the land for different purposes (recreation, hunting). The economic base for many of these new residents is outside the local area. Thus, given the expanding geographic scales of the social and economic processes that

affect the social-ecological systems of CBCs, it is important to "get the scale right" to maintain the adaptive capacity of these groups over the long term.

Recommendations for Enhancing the Adaptive Capacity of CBCs

The comparative case studies and ASESAC survey results presented in this report suggest eight actions that CBCs can take to enhance their capacity to learn and respond positively to change. Many of these measures are not new, but are part of the growing literature on "best practices" for collaboration (Wondolleck and Yaffee 2000, Tilt 2005).

1. Develop an explicit system model to guide management and monitoring based on shared understanding of how the CBC's social-ecological system works. This process may simply document what is already widely known by CBC members, but more often helps surface differing assumptions and perceptions of the system, and identify uncertainties and knowledge gaps.

2. Identify system drivers, limitations and potentials, and structure management and monitoring to reassess these aspects of the social-ecological system, and their relationship with the CBC, at regular intervals. The ability to recognize initial limitations and potentials, as well as new ones, is key to the CBC's ability to adapt to changing conditions.

3. Forge and articulate a shared vision for the CBC's landscape and community, and clear goals and objectives to support it. A shared vision and set of values is a crucial first step to successful natural resource collaborations. If the only thing a group agrees on is collaboration itself, this is not a strong foundation for future action. Values and interests within a group may vary greatly, but group members must find some common goal to work towards in order for collaboration to succeed. Often this process is long and tedious, but it is essential. A clear vision is important to help steer an organization in changing times.

4. Build and maintain trust through ongoing on-the-ground activities. Working together on the ground is one of the most effective ways to build community and a sense of shared accomplishment among group members. Trust, in turn, is one component of the relationships built through collaboration that helps CBC members work together effectively even when their views and values differ. These relationships and the trust that binds them help groups to overcome challenges and adapt to changing conditions.

5. Consider carefully the appropriate spatial and social scales for the collaborative effort. Is the spatial scale sufficient to incorporate key ecological processes? Does the social scale incorporate the main human communities that affect or are affected by management? Is the scale appropriate to involve or influence decision-makers in the key management organizations? Spatial scale is important so that sufficient area and diversity are included to maintain the adaptive capacity of the ecosystem. For example, if a plant population goes extinct locally, sufficient area must remain to harbor other populations and provide seed sources for reestablishment. Social scale is

important because an adaptive organization must balance inclusion of all relevant stakeholders with an effective size for collection decision-making.

6. Critically self-reflect about CBC governance structures. Is a broadly inclusive and participatory process essential, or does sufficient trust and understanding exist among stakeholders that many decisions can be delegated to an executive committee or director? Carefully evaluate the costs and benefits of horizontal (inclusive and democratic) governance versus more vertical governance structures. Adaptive organizations must be able to respond quickly to challenges and opportunities, but they must also enjoy broad legitimacy among their membership. Further, organizations in which leadership capacity and institutional, ecological and social memory is developed among many members may be more sustainable in the long term than those in which leadership roles are confined to one or a few individuals.

7. Develop a structured process for on-going planning and self-evaluation of ecological, social and organizational goals and impacts. Adopting a conscious commitment to learning and self-evaluation is one of the most important steps a group can take to build its adaptive capacity. Simply gathering monitoring data is not helpful if these data are not analyzed, shared, and evaluated in a decision-making framework.

8. Since bureaucracy and regulations will inevitably affect CBCs, these obstacles must be anticipated and, to the extent possible, proactively addressed. This can be done through self-education about key laws and policies, by developing clear and open communication with agencies and governments (and insisting on transparency), and by working on multiple projects at different scales and/or on different land ownerships at the same time. Many successful CBCs (such as DT and MGB) have weathered protracted NEPA reviews or other bureaucratic hurdles by getting work done on the ground where opportunities existed, while patiently shepherding other projects through red tape. It is also important for CBCs to separate the individual agency employees from the institutional and organizational structures within which they work.

Assessing the Adaptive Capacity of CBCs: Lessons Learned and Next Steps

This research project explored the concept of adaptive capacity as a criterion for evaluating community-based collaborative groups by developing a conceptual framework and testing qualitative and quantitative applications of the framework to evaluation of 3 rangeland CBCs. Adaptive capacity remains a compelling criterion, but further refinement of the concept and measurement tools are needed for it to be really useful to researchers and CBCs. An insight at the conceptual level is that assessing adaptive capacity includes but is different from assessing a CBC's ability to implement adaptive management. Our adaptive capacity framework differs from the adaptive management cycle in its attention to socio-economic and ecological contextual variables, and the CBC's awareness of and interactions with the larger social-ecological system in which it is embedded. Ultimately, the CBC's responses to stresses and opportunities within this larger system determine its adaptive capacity. Our framework posits that a CBC group's intentional approach to learning from the social-ecological system, and its changing

awareness of, responses to, and effects on the system, are key components of its ability to learn and innovate.

Next steps in the development of an adaptive capacity framework and evaluation tools for CBCs include 1) further refinement of the concept through dialogue with interested CBCs, 2) defining and describing adaptive capacity in language accessible to and transferable among CBC groups, 3) and refining the ASESAC survey as a tool a) for researchers conducting cross-sectional research on multiple CBCS and b) as a self-evaluation tool for CBCs to use. Finally, there is still a need to identify robust ecological and socio-economic criteria for cross-case comparisons of CBC outcomes, particularly as they relate to adaptive capacity of social and ecological systems. This project has identified indicators used by each of our three study CBCs, as well as proposing qualitative and quantitative indicators for cross-case comparisons. Further cross-sectional research on larger samples of CBCs is needed to evaluate the sensitivity, validity, robustness, and utility of these indicators.

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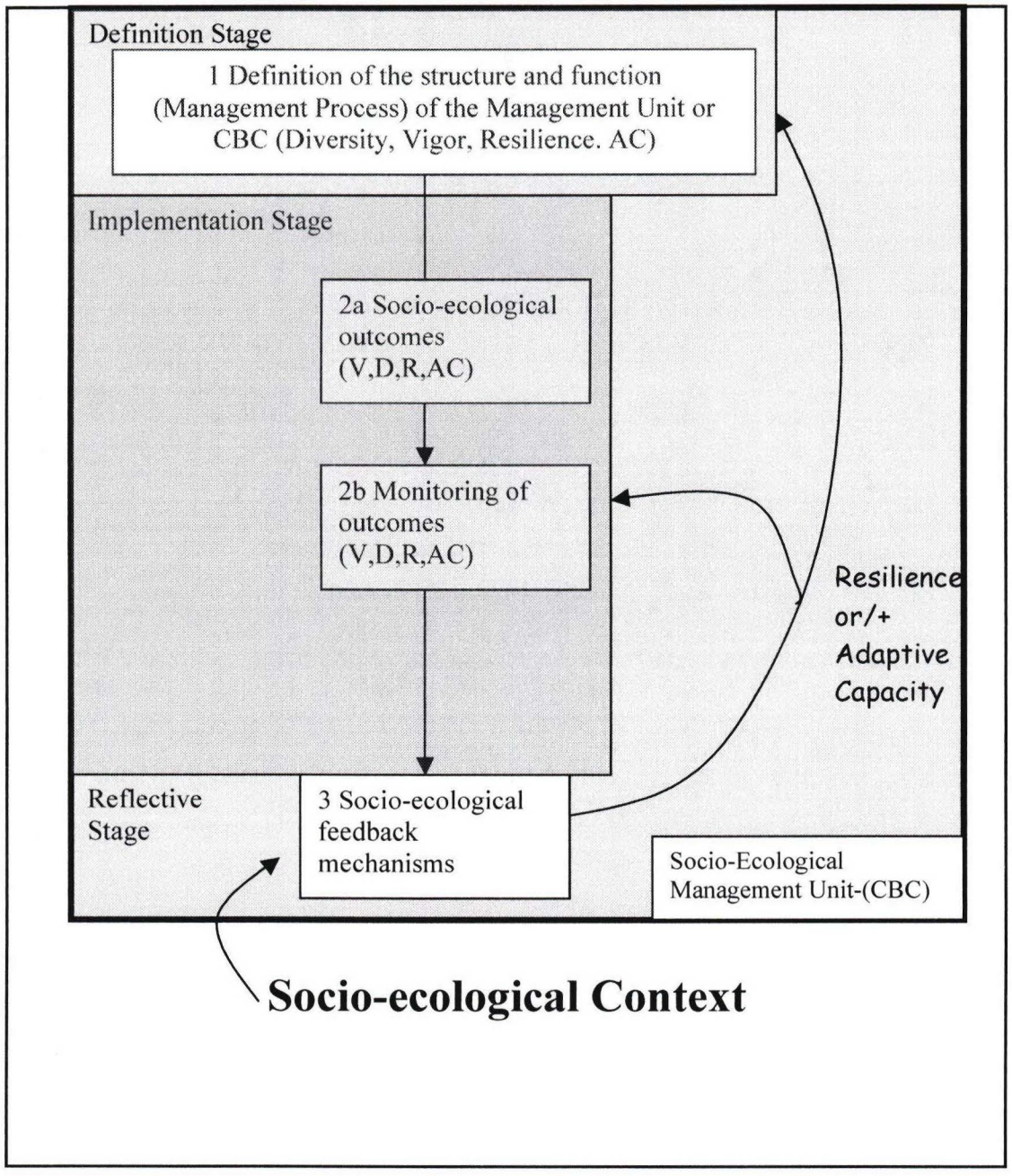
Figure 1. Conceptual framework for assessing the adaptive capacity of community-based collaboratives.


Definition Stage
1 Definition of the structure and function (Management Process) of the Management Unit or CBC (Diversity, Vigor, Resilience. AC)
Implementation Stage
2a Socio-ecological outcomes (V,D,R,AC)
2b Monitoring of outcomes (V,D,R,AC)
Resilience or/+ Adaptive Capacity
Reflective Stage
3 Socio-ecological feedback mechanisms
Socio-Ecological Management Unit-(CBC)
Socio-ecological Context

Tables

Table 1. Distributions of points for stages and categories in the quantitative analysis tool.

Criteria	**Points**
I. DEFINITON STAGE	**600**
1. Structural characteristics	195
2. Functional characteristics	245
3. Recognition of system limitations and potentials	160
II. IMPLEMENTATION STAGE	**600**
1. Socio-ecological actions and outcomes	220
2. Monitoring tools	178
3. Recognition of system limitations and potentials	150
III. EVALUATION STAGE	**800**
1. Information processing	300
2. Influence on the definition and implementation stages	300
3. Recognition of system limitations and potentials	200

Table 2. Summary of ASESAC evaluation for each case.

	NWCOS	DT	MBG
Definition Stage Total	53.7	56.7	77.6
Structure	51.3	53.1	87.7
Function	65.7	59.9	74.7
Recognition of limitations & potentials	40	56.1	60
Implementation Stage Total	58	56.5	76.7
Process	47.3	65.7	92.1
Outcome	64.3	62.5	86.1
Monitoring	56.7	61.6	73.9
Recognition of new limitations & potentials	60	39.6	64
Evaluation Stage Total	0	0	78
Information processing	0	0	80
Influence on Definition & Implementation stages	0	0	72
Recognition of limitations & potentials	0	0	84
OVERALL TOTAL	56.1	56.6	77.5

Table 3. Summary of descriptive criteria for the three case studies.

	NORTHWEST COLORADO STEWARDSHIP	THE DIABLO TRUST	MALPAI BORDERLANDS GROUP
		Definition Stage	
Biophysical Setting	Colorado Plateau rangelands Salt shrub, sagebrush-grass, pinyon-juniper, riparian (small amounts of forest and alpine) 8?-16 inches annual ppt.	Colorado Plateau rangelands and forest Sagebrush-grass, pinyon-juniper, ponderosa pine, riparian 8-24 inches annual ppt.	Desert grasslands (Chihuahuan Desert) Desert grasslands, mesquite shrublands, oak savannah 5-25 inches annual ppt.
Landownership	BLM	USFS, AZ State Lands, private	private, USFS
Spatial Scale	1,300,000 surface acres	426,000 acres	1,000,000 acres
Year Founded	2003	1993	1989 (initial meetings)
Structure (Participation)	County + BLM-initiated multistakeholder, open membership	Rancher-initiated Multistakeholder, open membership	Rancher-initiated Ranchers with agency, NGO and scientist partners/advisers, closed membership
Function (Decision-making)	Consensus-based Outside facilitator	Consensus-based Self-facilitated	Hierarchical Self-facilitated
Mission/Goals	Improve public lands decision-making through collaboration by promoting commonly held values and principles.	Demonstrate innovative approaches to restore and maintain the natural processes that create and protect a healthy, unfragmented landscape to support a diverse, flourishing community of human, plant and animal life through mutual support and cooperation with the local community.	Restore and maintain the natural processes that create and protect a healthy, unfragmented landscape to support a diverse, flourishing community of human, plant and animal life in our borderlands region. Encourage profitable ranching and traditional livelihoods to sustain open space.
System Model	Yes, draft models developed to understand OHV impacts encompassing ecological and social variables; fuels model included ecological variables only	Yes, formal model developed that encompasses ecological and social factors.	Yes, formal model developed that focuses on ecological variables.
Limiting/driving factors	Precipitation, fire, herbivory, Policy/legal constraints (FACA, NEPA)	Precipitation, fire, herbivory Policy constraints (NEPA)	Precipitation, fire, herbivory, fragmentation Policy constraints (NEPA, ESA)
System potentials	Local political capital BLM collaboration resources		
Management Plan	No general plan NWCOS contributing to BLM area management plan Project-level fuels mgt plan	Range management plan 1999, EIS approved 2005	Programmatic fire plan Habitat conservation plan 10-year organizational plan 2004

		Implementation Stage	
Management Actions	Fuels treatments/habitat improvement	Fuels thinning & habitat improvement on private and state lands No action on USFS lands due to NEPA delays	Conservation easements Prescribed fire reintroduced
Outcomes	Increased structural and age-class diversity (assumed) Increased knowledge New relationships Trust NOT increased	Increased grassland and forb productivity (monitored in treated areas) ~ 80,000 acres of woodlands treated Increased trust, although frustration with agency regulations and NEPA Increased knowledge New relationships, active participation and community awareness	42,000 acres under easement ~200,000 acres burned in prescribed + natural fires Increased trust and improved rancher-agency relationships
Monitoring	Baseline monitoring for OHV use No post-project monitoring of fuels project Process monitoring (limited) No socio-economic monitoring	Rangeland monitoring ongoing HEHI indicators developed and implemented Process monitoring Socio-economic variables in HEHI	Landscape scale monitoring for easements, fire effects, grazing effects No socio-economic monitoring No process monitoring
Research	Social research on adaptive capacity and social capital.	Plot-scale experimental research on grazing effects on vegetation, invertebrates, ecosystem processes	Landscape scale experimental research on grazing, drought and fire effects on vegetation and wildlife
New Potentials & Limitations Recognized	Challenges of adaptive mgt. and monitoring Benefits of research partnerships	NEPA constraints Rural Planning Area opportunity Organizational restructuring	Agencies accept fire as a tool Ranchers recognize benefits of collaboration with NGOs and v. versa Benefits of applied community-base science realized
		Reflective Stage	
Feedback Mechanisms Potentials & Limitations	Undeveloped, but philosophically committed to adaptive management	Not yet obvious; undeveloped	Undeveloped. Intentional decoupling of monitoring & grazing management